

Conditioning Biochar



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VISIT...

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Biochars are:

Granular and Highly porous.

Highly “Recalcitrant”: Resists microbial degradation
(potentially non-biodegradable for hundreds of years)

Highly Adsorptive

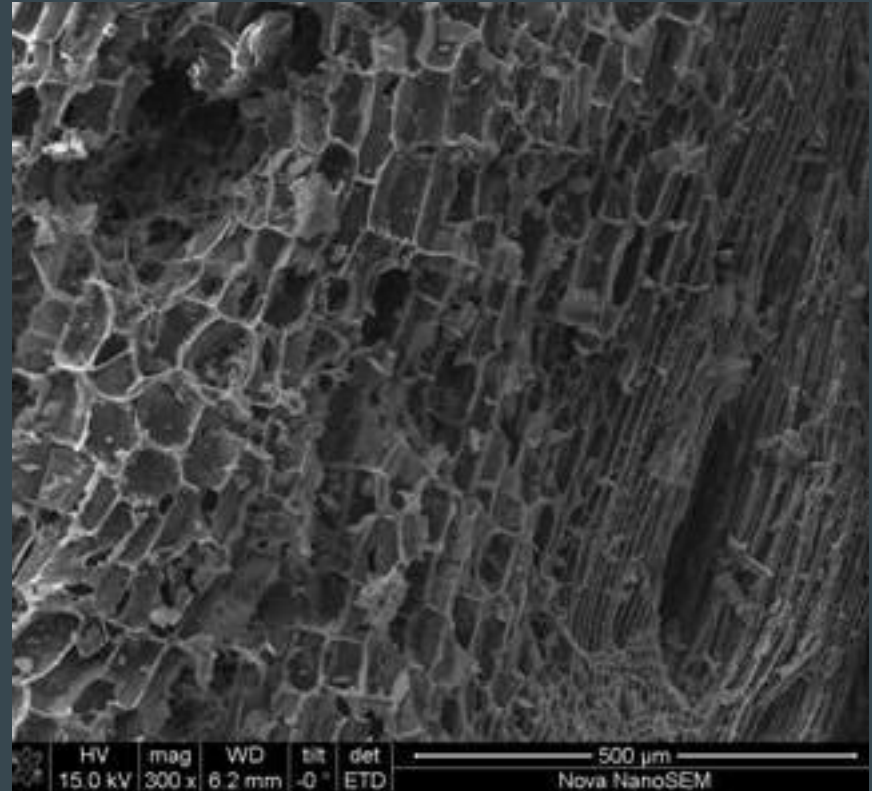
Generally alkaline, some more than others

Usually crushed and screened from ¼” to dust



Nutrients, Microbes, and Substrates

- **Charging** (adding nutrients) to biochar
- **Inoculating** (adding microbes) to biochar
- **Substrate:** Nutrients stick to the walls of biochar, Encouraging microbes to “move in”



Source: IBI (Biochar-International.org)

Why Bother?

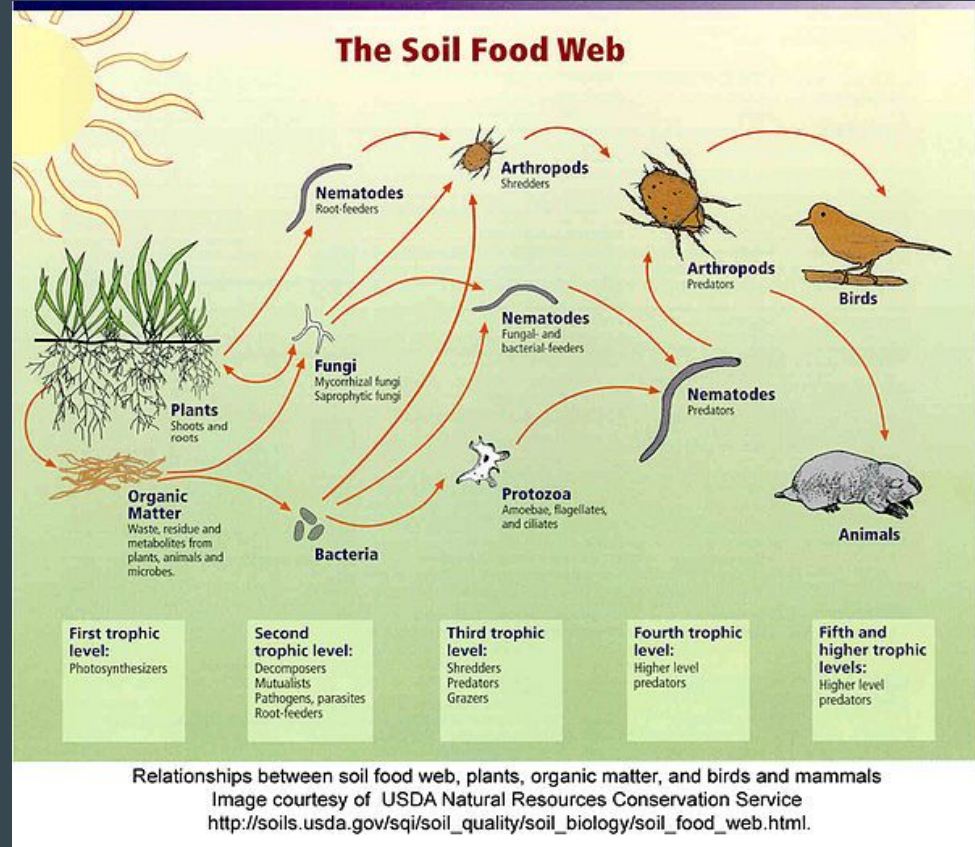
- Adsorptive biochar will likely ‘suck in’ soil’s nutrients when applied raw.
- Conditioning char allows you to hit the ground running on crop production, ‘jump-start’ the ‘soil food web’, and restore damaged soils.
- Biochar can be a vehicle for custom blends of microbes and microbial foods catered towards specific plant needs

Important to note: Nature will correct itself. If raw biochar is applied to living soils with adequate organic matter, Eventually it will recover.

If biochar is conditioned with expensive ‘designer microbes’, nature will likely outcompete. Inclusion of ‘Indigenous Microbes’ may prove a more effective strategy

Remembering the Soil Food Web

- Emphasizes complex relationships of give and take among organisms in soil.
- Diversity of microbes is key to healthy soil that is resilient to changes in moisture, nutrients, pH, etc.
- Biochar aids diversity by moderating stressful conditions and creating a stable habitat for microbes
 - Drought, excessive rain
 - Nutrient over/under application
 - Tillage/physical disruption



Guidelines for Conditioning Biochar

- Consider a Nutrient source AND a Microbial inoculant
- Nutrient and Microbe diversity is preferred
- Char should be wetted: encourage adsorption, resist floating
- Consider pH. Some chars may have high ash content and may benefit from rinsing with rain water or soaking in organic acids. (Nature will eventually correct)
- Application rates of biochar vary - 1-10% by volume typical.
- Maintain Aerobic Conditions for pathogen prevention

Speaking from Experience:

Quenching hot biochar with mineral rich water is a great way to wet biochar while hot steam will potentially crack open more pores and rinse residual tars.

Vocabulary:

- **Conditioning:** Process of preparing biochar for soil application, through addition of nutrients, microbes, and/or minerals.
- **Microbes:** Broadly - Microorganisms, though we're referring to common soil microbes: bacteria, archaea, fungi, along with Protozoa and Nematodes. In other words: *Soil Life*
- **Aerobes:** Microbes that require oxygen.
- **Anaerobes** require absence of Oxygen. Employed in fermentation processes
- **Facultative Microbes:** capable of surviving in both aerobic and anaerobic environments
- **Nutrients:** Microbial food, or Plant food.
- **Organic Matter:** In soils, is humus, plant detritus, microbes - plant and microbial food.

Easiest: Mix with finished compost

- Nutrient charging and microbial inoculation in one shot
- Mix char and compost at ratio as high as 1:1 (50/50)
- Maintain moisture *after mixing in char* - squeeze test
- Compost markets are dominated by inferior compost, quality fungal compost has been very difficult to find.
- Be prepared to wait at least a few weeks - assuming conditions are right (moist, warm and aerobic) and compost is high quality.

Speaking from Experience:

Biochar has the potential to hold a LOT of nutrients. Best to err on side of caution - try higher ratios of compost to char (3:1) or pre-treat char with nutrient rich liquids.

A microscopic view of compost, showing a dense field of orange-brown fungal hyphae and spores. A prominent, long, thin, and slightly curved hypha runs vertically through the center-right of the frame. Numerous smaller, rounded spores and clusters of hyphae are scattered throughout the background. The overall color is a warm, orange-brown, typical of compost under a microscope.

Fungal activity in compost

Vermicompost

- Scalable, easy home ‘composting’
- 2 lbs of worms - 1 lb/day of food waste
- Moderate temperatures req’d. 55-77 preferred
- Moisture management is critical
- No dairy, fats, meats, citrus, salty foods, etc.

Speaking from experience:

- Use more carbon than typical composting - don’t want it to heat up.
- Eggshells for grit - Calcium buffer against organic acid buildup
- Worms love structure - cardboard, mine love spent luffa sponges
- It helps to chop large veggies - my worms won’t eat a carrot
- Many seeds are still viable after vermicomposting - watch for weeds!
- Manage moisture, and it’s smell free.
- Move in the basement for the winter, cool shady spot for the summer





Vermicompost, continued

- Great source for macro and micro-nutrients. N, P, K, Mg
 - Also, Hormones and Growth Regulators - more science is needed
- Great source for microbes: bacteria, fungi, protozoa and nematodes
- Aerated 'Tea' from castings can multiply microbes
- Little goes a long way, but excess won't 'burn' plants
- Vector for human pathogens?
 - Again, more science is needed. Opposing studies on if 21 days is adequate to eliminate E. Coli.

Conditioning Biochar? Great for nutrients and microbes in one when mixed directly.

Same rules apply when mixing with raw biochar: err on side of caution with higher castings to char ratios.

Actively Aerated Compost Tea

- Microbial extraction... and multiplication
- Ingredients: Good compost, Microbial foods, and lots of AIR
- Compost tea can be applied foliar, as soil drench, compost accelerator
 - Biochar inoculation: important to provide adequate nutrients
- Many recipes available, simple to complex.
- GREAT microbial inoculant, If tea is brewed well, all microbial foods will have been consumed.
- Not a complete biochar inoculation system. Consider soaking char then mixing with a complex high organic matter nutrient source.

Speaking from Experience:

Amazing results require a bit of extra effort and attention to detail. Simply put, so long as there is appropriate air, get it wrong and worst case is your tea isn't doing anything. Without air, possible multiplication of pathogens.

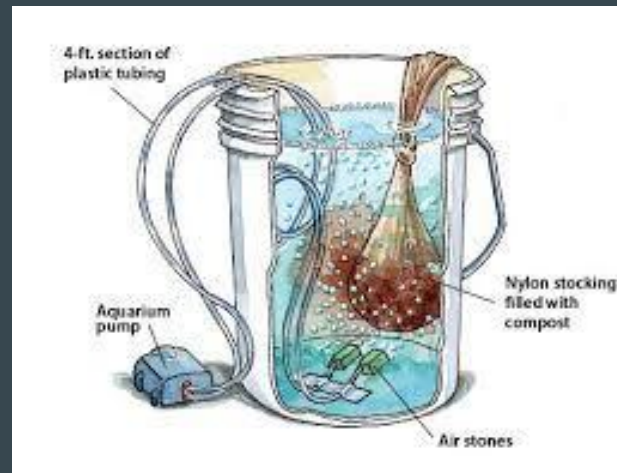


Image source: motherearthnews.com

A microscopic view of actively aerated compost tea. The background is a uniform orange-brown color. Scattered throughout are numerous small, dark brown to black particles of varying sizes. Some of these particles appear to be elongated or chain-like, possibly representing bacterial structures or organic debris. There are also some lighter, more irregularly shaped particles. The overall appearance is one of a complex, heterogeneous mixture.

Bacteria Diversity along with higher trophic
levels of life in Actively Aerated compost tea

Liquid Gold

- 10:1:4, NPK plus some trace elements
- Store for a 30 days above 68 degrees for sterilization. **Science is still out on this.**
- Dilute 1:5-10 for direct application to soil.
- No need to dilute for charging biochar
- J. Joyce: composting with biochar
 - 2 liters urine / 1 liter biochar (will req. evaporation)
 - C:N ratio is 1:1
- Beware salt accumulation.
 - Waldeneffect.org: Dilute to 1,700 ppm TDS
- Beware pharmaceuticals.
- Wetting and Charging in one step
- (Hopefully!) not a microbial inoculant
- Probably best done before composting, adding microbes.
- Do your own research. Proceed w/caution.
- **Guarantee safety with PFRP. Not a LWF recommendation**



Source: waldeneffect.org

Bokashi 'Trash Juice' and other Fermented liquids

- Unique 'composting' system is a 3 step process:
 - Inoculate food wastes with EM proprietary microbes (or start your own Lacto Bacillus)
 - Store in Airtight container for a few weeks
 - Move 'pickled' waste into aerated compost pile, or bury directly in soil.
- Allows for fast and safe composting of food wastes: including meats, fats and dairy
- Fermentation process prevents pathogens, kills seeds.
- Advocates claim it can be done indoors - not my experience yet!
- Yields an Acidic, nutrient and (facultative) microbe loaded leachate
- Trash Juice: Nutrient array depends on what goes in. Goes foul quickly.
- Can be used as liquid inoculant, nutrient source and pH balancing agent in biochar conditioning. Further mix with organic carbon source: compost, worm castings or mix directly in high OM soils.











Bokashi Leachate

EM - “Effective
Microbes” Starter

Leachate includes:

“photosynthesizing
bacteria, lactic acid
bacteria, yeasts,
actinomycetes and
fermenting fungi”



Mix AS compost

- No need to purchase ‘designer microbes’
- Many people are already familiar with principles of composting
- Many benefits in compost pile
 - Improved bulk density, texture, gas movement and moisture management
 - Adsorbs Ammonia, GHGs - studies reveal char is found to reduce losses of nitrogen gases
 - Pre-charged char can become ‘seed’ for composting - possibly speeding up process
- Guide for composting biochars: J.Joyce: Conditioning Biochars for application to Soils
 - Acts as a ‘black’ carbon source, with your ‘browns’ and ‘greens’.
 - Slow pyrolysis chars (our methods) would benefit from pre-treatment before composting

Speaking from Experience:

- Think seasonally for at-home composting: if you’re like me, you won’t have enough material to adequately compost until garden cleanup, harvest, leaf drop, final mow.
- Add raw char along with bokashi ferment to pile, add pee char in carbon rich piles

Another Approach: Cascading Uses of Biochar

From Ithaca Journal: 55 Uses for Biochar - Hans-Peter Schmidt 2012

- Immediate conditioning of biochar for soils may not realize full potential of biochar applications: consider alternate uses for char before applying to soils
- Schmidt identifies 55 definitive applications, along with citations, including:
 - Animal farming applications: litter additive, fish farming water treatment, feed additive
 - Building materials: air filters, humidity regulation, insulating material composites, EM shielding
 - Soil and Water decontamination, Stormwater Runoff
 - Composting toilets, biogas production
- Key is realizing potential as an adsorbent filter medium (especially when bio-available nutrients and minerals are what's being filtered!) prior to conditioning as a soil amendment.

Review: Conditioning Biochars

- Generally speaking, Biochar should be crushed and screened to $\frac{1}{4}$ or less
- Applied raw, biochar will chemically draw in and hold nutrients in the soil
- Condition biochar through the addition of nutrients
- Benefit further by conditioning biochar through the addition of microbes
- Biochar should be 'wetted' prior to, or as part of a conditioning process
- Choose a nitrogen source that works best for you.
- Best practice: condition char with high organic matter nitrogen source, store in conditions that are favorable to composting: moist, and warm, with adequate air.
- Char is expensive! Economize with appropriate 'cascading' applications
- Consider a mycorrhizae inoculant upon biochar application to root zone
- Application rates are widely variable - .25-2.5% by weight, 1-10% by volume, root zone application is preferred

References and Recommended Resources:

Conditioning Biochar for application to Soils: James Joyce, 2009

Biochar Use in Soil, Guidelines and Instructions for Growers: David Yarrow, 2014

Ithaka Journal - 55 Uses of Biochar: Hans-Peter Schmidt, 2012

Compost Tea Brewing Manual 5th ed.: Dr Elaine Ingham, 2005

Manual of On-Farm Vermicomposting and Vermiculture: Glenn Munroe